REMOTE SENSING TECHNOLOGIES AND SAMPLING METHODS IN ARCTIC AND ANTARCTICA

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Abstract

In last four years scientists from the University of Latvia have carried out six scientific expeditions in the Arctic and the Antarctic focusing on geophysical studies of modern glaciers and performing interdisciplinary studies in the fields of geology, geomorphology, glaciology, soil science, remote sensing, and microbiology. Scientific expeditions to Iceland were carried out in 2014, 2015, 2017 and 2018, and the expedition to Greenland was accomplished in 2016. In the last year's (2017) expedition to Iceland, researchers tested new study methods and equipment, which were used for future research in the Arctic and Antarctic. The first Latvian scientific expedition to Antarctica was carried out in 2018.

The main goal in these polar expeditions was an investigation of glacier thickness, structure and subglacial topography using ground penetrating radar (GPR). GPR measurements were performed by GPR Zond 12-e and 38 and 75 MHz antennas. Assuming that the average dielectric permittivity of ice is equal to 3.5, it allowed detecting the reflections of depth up to 160 m beneath the ice surface. The coordinates of each GPR profiles and sampling points were determined by GPS system Magellan Promark 3 or Emlid Reach RS+ that are composed of two GPS receivers. Working with this particular GPS allowed us to take measurements and post-process results with geodetic accuracy, with or without GSM or radio support.

Surface topography of the glaciers is articulated, as a result, GPR data gathering and creation of precise surface elevation maps is difficult. Starting from Greenland expedition in 2016, aerial unmanned vehicle (UAV) is used to create three-dimensional models of the marginal zone of glaciers. Surface elevation maps of the surveyed part of the glaciers were created using a large number of aerial photographs captured with drone DJI Phantom 3 advanced and DJI Phantom 4 Pro V2.0. To anticipate bad weather and high risk of wind, in the last expedition to Iceland Dji Mavic Air was used as a reserve in case of possible technical problems with main UAV. To control UAV and generate missions DJI GO4, Drone Harmony and Pix4Dcapture apps were used. Usually, flight altitude was 60-70 m with profile overlap of 80-85%. Digital elevation models and orthophoto maps of the research areas with the precision of 5 cm were created with Agisoft and Pix4D Mapper software. Models of the subglacial topography and ice surface were created by SAGA GIS software and Thin Plate Spline (Global) interpolation method.

A number of issues were encountered during the capture of aerial photographs with UAV during expeditions. Smallest of them were damaged and wearied out connection cables even they were new. Incomprehensible problems are associated with aircraft and remote controller connections, signal lost or apps support.

In addition to these investigations, sediment, water, and cryoconite samples were collected from ice, as well as from different environments as small ponds, streams, and inlets to characterize sand formation processes, soil development, and microbial diversity in this part of Arctic and Antarctica.

Keywords: aerial unmanned vehicle, three-dimensional models, ground penetrating radar

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